cients inapplicable over the range of atmospheric conditions met with during the summer throughout the United States. Still further refinement will no doubt be attained in the future, but the instrument appears already to be amply precise for all the studies in which it has thus far been employed.

It should be remembered here that none of the atmometers employing imbibed solids are available for the study of evaporation in freezing weather. Pans of ice or of a nonfreezing solution are the only instruments thus far available for this important case of direct-measurement atmometry.

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(2) The points brought out in the present paper have been considered in a somewhat different way and more fully, in some respects, in the following publication (which also contains numerous references to the literature),—
Livingston, Burton E. Atmometry and the porous cup atmometer. Plant world, Tucson, 1915, **18:** 21–30, 51–74, 95–111, 143–149.
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(12) **Harvey, E. M.** The action of the rain-correcting atmometer. Plant world, 1913, **16:** 89–95.

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THE INTRODUCTION OF METEOROLOGY INTO THE COURSES OF INSTRUCTION IN MATHEMATICS AND PHYSICS.

By CLEVELAND ABBE, Professor of Meteorology.

[An address delivered before Physics and Mathematics Sections of Central Association of Science and Mathematics Teachers, Chicago, Nov. 26, 1904.]

The study of meteorology has acquired a new and vivid interest since the establishment of fairly successful official weather forecasts in this country and Europe. The civilized world now knows that the weather and the climate, the winds and storms are controlled by rigorous laws of nature; we may not understand these laws as yet, but they are in control of the universe and we are to discover them and utilize them for the benefit of mankind. We have not yet found any limit to the attainments of the human intellect, and what the mind can do in the way of thinking the hand will find some means to attain in the way of doing. We must think out our work before we can do it.

The ultimate object of all our systems of education, elementary, collegiate, and post-graduate is to train the mind to think and then train the hand to do. In old times the schools crammed the brain with the results of work already done, memorizing a multitude of facts; but now, while not neglecting the memory, we seek to develop the reasoning faculties, or the reasoning habit of thought, and then to perfect our methods of doing. Our schools pay much attention to mathematics, mechanics, chemistry, and science in general, because these have an important practical bearing on our lives. In this movement toward the professional side of education meteorology has not been neglected altogether. I have been greatly pleased to see the enthusiastic reception accorded it in every part of the Union and its growing popularity in both graded and high schools. I suppose that we owe this specifically to the general success of the Weather Bureau, but more particularly to Prof. Wm. M. Davis, who established a school of meteorology about 1878 as a division of the school of geology at Harvard University. His students and textbooks, his Elementary Meteorology and the Climatology of his successor, Prof. R. DeC. Ward, and their methods of teaching have awakened teachers and professors alike to new possibilities. Other schools and other textbooks have come into existence. The elements of the subject are now so well provided for that I do not need to say more about this; but I do feel the need of further advances.

I regard meteorology not so much as a matter of observation and generalization as matter of deductive reasoning. Our studies have approached the limit of what we are likely to discover by inductive processes. We stand where astronomy stood in the days of Laplace. We have had our Galileo and Newton, but we still need other leaders, and you will all agree with me that these must be trained in the schools. They must get their first lessons from you. Twenty or thirty years hence our future masters in meteorology will tell how their feet were turned in the right direction by the teachers of to-day.

In every school I find several boys or girls that have taken a deep interest in the weather and its relations to our lives. They are often asking questions that bear upon it. They appear to observe and understand it better than others. These are they whom I would have you secure for the possible service of the Weather Bureau. There are others that often appear dull, but are not really so; their previous education has perhaps been imperfect, some one has confused their minds with erroneous ideas from which they can not easily rid themselves. There are others who have not yet awakened to a full interest in intellectual work. In general, the school will be benefited by taking up exact and experimental work as compared with inexact, indefinite, texts or phrases. We benefit a child more than we realize when we give him exercises in exactness. Why do we make him calculate interest to the last cent? Why practice the piano or singing until he can do it properly? Why draw or paint correctly? Why speak English precisely? Is it not our conviction that what is worth doing at all is worth doing well? It is only the things that are well done that tell. Even in morals it is the bad thought that is the first step toward a bad act. So I wish to enforce the idea of teaching meteorology accurately, and to do this we must use accurate expressions and experiments, accurate figures and drawings, and correct mathematics. On the other hand, we enliven all mathematical and physical courses of instruction if we introduce into them applications to familiar subjects. The dullest student becomes alive as soon as he perceives that his distasteful mathematical tasks will help him to understand some subject that really interests him. There is no one, not even a child, that has not some favorite subject of thought, some one unanswered query, lurking in his brain. Find out what that is and you have found the keynote to which all his education may be made harmonious.

I know that the schools and colleges find so many subjects to teach and the hours of work are so taken up at school and at home that you will say it is out of the question to introduce another new study. However, I do not venture such a presumption, but would suggest a simple and practical scheme. The idea is simple.

When you are teaching mathematics or physics and seeking for examples illustrative of the application of these subjects, give special attention to meteorology and take your examples from the phenomena of the atmosphere. You may not at first find many cases, certainly there are very few in the books. You may have to draw upon your own reading and knowledge, or on the notes that you will find in the MONTHLY WEATHER REVIEW. But with a little ingenuity you will soon accumulate quite a goodly number of problems that will afford your students abundant food for thought.

I find that many take up mathematical physics as one of the courses leading to the various engineering professions, because the latter offer them a prospect of a good business for life, but occasionally one of these finds himself interested in the scientific or research aspect of the various problems as much or even more than in the engineering aspect. He will probably combine research with his business, if indeed he does not altogether relinquish the latter for the former, provided a favorable opportunity offers. Now, of such are the men from among whom the ranks of the future army of American scientists will largely be recruited, and if you find any such you will do well to help them develop their tastes for meteorology. They have studied mechanics, thermodynamics, steam engineering, electrical engineering, hydraulic engineering; they are graduates of our schools of engineering, they have also the very best foundation for research in meteorology, and their tastes incline in that direction. One can not expect to make any great advance in this science without having both a broad foundation, an inquiring mind, and great intellectual energy and perseverance.

If the colleges and universities are not yet ready to give meteorology an independent place, a professorship, an observatory, a laboratory, as they do for astronomy, chemistry, geology, and many other branches of knowledge, then the best temporary arrangement that we can make is to introduce it freely among the illustrative problems of the general courses in the fundamental mathematical, and physical studies of all exact science. But you will ask for some definite examples, and I have time to mention a few.

(1) Among the simpler applications of trigonometry are the various efforts made *to determine the altitudes and motions of the clouds*. The simplest method consists in determining the actual motion of a cloud by observing the perfectly parallel and equal movement of its shadow on the ground. One may stand upon an eminence and survey the landscape and with the help of a good map and the seconds hand of a watch or a simple seconds pendulum, may determine the direction of motion and the linear velocity of as many shadows as he wishes. If now at the same time he looks directly upward and observes the apparent angular velocity of a cloud as it passes the zenith, he will find that he knows the base and one angle of a right angled triangle, of which the other side is the cloud-altitude, which of course can then be computed by trigonometrical tables or, still better, by geometrical constructions. Trigonometry and geometry, arithmetic and algebra should all be kept at the finger tips ready for use by young students of science. Oftentimes a young man will stand in front of a theodolite or some other complex apparatus and feel that it is too much for him; some have their heads full of mathematics, but do not know what to do with it. The expert is the man who has the knowledge and can also do something with it. Our education should insist on the practical and quick utilization of every scrap of knowledge that we are the fortunate possessors of.

(2) Another ingenious application of geometry to the altitude of clouds is known as Feussner's method.[1] An observer stands at O and sees a shadow at K at a spot that he can identify on a detailed map of his surroundings. He recognizes that this shadow is that of a cloud at C and he therefore observes the apparent angular altitude of that cloud, which is the angle COK in the triangle. Now the angle CKO is the same as the apparent angular altitude of the sun, since a line drawn from O to the sun would be parallel to the line drawn from K through C to the sun. If, therefore, the observer measures the angle by which the sun is above the horizon or SOH, he then knows the base OK and the two angles at O and K and may compute or construct the vertical height of C above the horizon. There are several refinements to be thought of. K may not be on the same level with O; the cloud may have moved before he can observe its altitude and the sun's altitude, after having identified the shadow K as belonging to the cloud C. These refinements offer slight difficulties that may be overcome. If one has a correct watch he may simply observe the time when the shadow was at the point K and from that compute at his leisure the altitude of the sun.

(3) One of the oldest methods of determining the altitude of a cloud is known as Bernoulli's; the observer at O sees the cloud at C just as the last ray of the sun illuminates it. This last ray must have grazed the surface of the earth at some point W below the western horizon. By observing the time, we know at once the angle between the radii drawn to the earth's center from O and from W. This gives us the means of computing the distance from W to our vertical. But we also observe the apparent angular altitude of the cloud or the angle between OC and the vertical. We have now all the data needed to solve the problem. We have in fact three triangles to solve in succession. The problem becomes more complicated if we endeavor to allow for the refraction of the ray of light from W to C. I will not give the latter complex formula now, but may say that I hope to publish a long series of these problems in a little handbook [2] for the use of students and teachers and I think that you will not find them too difficult for most of your students. Authors of text-books on trigonometry which give us many interesting problems suggested by the work of surveyors, navigators,

[1] Feussner. Über zwei neue Methoden zur Höhenmessung der Wolken. Ann. der Phys. u. Chem., 1871, 144: 456–467.
[2] This handbook has not yet appeared, May, 1915.—*Editor*.

and geodesists, seem to have quite forgotten that the clouds offer us still more fascinating problems.

(4) Some years ago the various weather bureaus of the world agreed upon a year of steady work on the altitudes of clouds. Some observers adopted the strictly trigonometric method of altitudes and azimuths. If a theodolite is placed at A and another one at B, the observers endeavor to sight simultaneously on a cloud at C. If they sighted on the same point at the same time and observed the altitudes and azimuths correctly, then it would seem certain that with AB as the base line they should be able to compute the linear distance of the cloud C and its altitude. But unfortunately a cloud has considerable size and there is never an absolute certainty that A and B observe the same point. Accordingly there arises a very interesting problem as to what points they have observed. Oftentimes calculations showed that the two lines of sight did not and could not intersect, so that the shortest distance between the two lines would seem to be the proper place for the cloud. You will find all the details of this problem in chance or the theory of errors, as it is called, in a report by Elkholm and Hagström.[3]

(5) During that same year other observers used what is called the photogrammeter or the nephograph, which is simply a photographic camera mounted with altitude and azimuth circles. Photographs are taken of the same clouds simultaneously and from these we may proceed by several methods. Either (I) we may measure from the photographic plate angular distances of various points in the clouds and determine the distance and dimensions of the whole cloud, or (II) we may proceed graphically, set the photographs up in a frame, reproducing as nearly as possible the original locations of the two cameras and then, using threads as lines of sight, carve out in the air of the room a small model of the cloud itself. This latter process was, I believe, first carried out in England under the supervision of Prof. G. G. Stokes, the eminent mathematician, who was at that time a member of the Meteorological Council at London. In fact, that council has often included some of England's most famous men and we are indebted to them for a number of important methods in meteorology.

(6) But perhaps the most fascinating as well as the simplest methods of *studying the clouds is by means of the nephoscope*. This is a very simple instrument, merely a circular mirror held horizontally; you look into it and see the cloud by reflection, which saves the trouble of twisting the neck in an uncomfortable position. The mirror has a graduated circle corresponding to the azimuth circle; its center is marked by a dot or cross lines and there are a few concentric circles drawn around that. At one side of the mirror is a light vertical rod holding a little knob, which may be raised or lowered and turned around to any azimuth so that when one observes a cloud reflected at the center of the mirror, he may so adjust the knob as to bring its image also at the center. But the cloud moves away and the observer must then move his eye so as to keep the knob covering the cloud until the knob and cloud disappear together at the edge of the mirror or cross some one of the concentric circles. In this process the knob is the center or intersection of two lines of sight, one from the cloud to the knob in its first position and again from the cloud to the knob in its second position. The horizontal path described by the intersections of these lines with the face of the mirror, is a miniature of the horizontal path described by the cloud in the time required by the images to pass from the center to the rim. We obtain thus the direction of motion of the cloud and a horizontal line that may be converted into the angular zenithal velocity.

(7) The prettiest application of this instrument and perhaps the most elegant of all methods of determining the height and velocity of the cloud, I have called the *kinematic method*. The idea is this: If we are in a boat or on a train, our motion is combined with the motion of the cloud. We seem to attribute our motion to the cloud and the observed line is a resultant movement, that you easily obtain by compounding movements or forces by the method of parallelogram of forces. If we move from A to B in the boat with our nephoscope it is as though the clouds move from B' to A' in the parallel but opposite direction, but if the cloud is actually moving from B' towards X, then the result that we observe is the line $B'X'$ as seen from the boat. This apparent angular motion we are to observe first when the boat is going from A to B and again when the boat is going in some other direction, such as B to C, or even when the boat is stationary, or when the boat directly reverses its movement, which we can most easily accomplish by carrying our nephoscope on a trolley or in a row boat on a canal. Now these two observations, together with the known velocities of the boat, give us four known terms in a pair of trigonometric equations from which by elimination we determine the altitude and the actual velocity of the cloud. The most difficult point is to determine the velocity of the boat and the method is therefore best adapted to give accurate results when the nephoscope is being carried by a steady steamer or by a car that is pulled by a cable, going at a perfectly uniform rate of speed in different directions, as for instance through the streets of a city.

(8) In the purely mathematical department, I happen to think just now of the so-called Poisson's equation relating to *the behavior of pure dry air when undergoing adiabatic changes*. This is given in some works on analytical mechanics and is mentioned in the elementary works on physics. But the good student will appreciate it better if you will give him the demonstration based on principles which may be made almost purely mathematical and fundamental •

(9) When the same ideas are applied to the expansion and contraction of *moist air* with its changes from vapor into cloud and snow, we come upon a more complex problem in physics; but even this is so largely a question of pure mathematics that it may be included under that category, and I hope that you will make your scholars familiar with the elegant graphic methods introduced by Hertz, whose paper is fully translated in my "Mechanics of the Earth's Atmosphere"[4] and has been still more beautifully treated by Neuhoff in a German paper in 1900 but not yet translated.[5] Elaborate mathematical tables are given by Professor Bigelow in his "Report on International Cloud Observations."[6]

(10) The elementary textbooks on physics often mention the theory of the wet-bulb thermometer and its use in determining the moisture of the atmosphere, but they rarely give any satisfactory explanation of the process by which physicists have deduced the relation between the temperature of the wet bulb and the moisture in the air—that is to say, the rate of evaporation; the process is not so difficult but that anyone who has studied a little of the law of diffusion can understand it, and for brevity's

[3] Mésures des hauteurs et des movements des nuages, par N. Ekholm et K. L. Hagström. Upsal. 1884.

[4] **Abbe, Cleveland.** Mechanics of the earth's atmosphere. A [3d.] collection of translations. Washington, 1893. (Smithsonian misc. coll., 843). Pp. 198-211.

[5] This paper by **Neuhoff** has since appeared in English in—
Abbe, Cleveland. Mechanics of the earth's atmosphere, a [3d] collection of translations. Washington, 1910. Smithsonian misc. coll., v. 51, no. 43, pp. 430-493.

[6] **United States Weather Bureau.** Report of the Chief, for 1898-99. Washington, 1900. Vol. II. 787 p. 4°.

sake I must refer you again to my "Meteorological apparatus and methods."

Mathematics and physics go hand in hand so closely that we dare not think of separating them. If one experiments, he keeps the mathematical laws in mind: if he studies the subject mathematically, he keeps the physical laws in mind. A problem in one is also a problem in the other; both are rigorous and develop the reasoning powers; but sometimes it is easier to handle the experimental than the analytical method.

(11) In the MONTHLY WEATHER REVIEW for 1897 (pp. 296–302, 445) will be found a splendid memoir on the equations of hydrodynamics arranged for the study of the general circulation of the atmosphere. This and the corresponding solution of the complex differential equations give the mathematician more than he can handle at present, but the suggestive paper by MacMahon, read at the recent International Scientific Congress on the *n*-fold Riemann surface, opens up great hopes for the future.

(12) Meanwhile we must mingle experiment and theory; each must guide the other. The physicist may, in his laboratory, carry out some of the following experiments and at a glance perceive the resulting atmospheric motions that are equivalent to the solution of the differential equations under any given special conditions; the analyst would find it difficult to attain these but can easily confirm them when once the result is known.

We may experiment on small local motions before proceeding to the larger ones.

(13) In a large room or in a case with double glass walls, so that the inside temperature may be controlled, let a shallow stream of cool air flow along the bottom. By giving this a slight but adjustable slope the rate of flow may be regulated; by altering the bottom we may pass from water or smooth sand to wavy, rolling prairie or ranges of hills and mountains. We may imitate every variety of ordinary atmospheric motion.

By utilizing a layer of CO_2 for the bottom we may study the flow of upper air currents over lower ones.

(14) We make all these movements visible by introducing a little smoke, but especially by applying the so-called schlieren method of Foucault, as perfected by Mach and Dubois, which enables us to photograph the feeblest differences of density, whether due to pressure or temperature or moisture.

(15) Among other problems in aerodynamics should be mentioned that most elementary one, the hypsometric formula of Laplace. Our students and the surveyors and mountaineers use this with aneroids for determining altitudes without understanding its derivation or the sources of mistakes in applying it, especially the uncertainty of our knowledge of the temperature of the air. Now the formulas may be deduced analytically by integration of the simple differential formula or by algebraic or geometric or arithmetic or graphic methods, and all should be combined as an illustration of the unity of logic in whatever form presented. Science is but logic applied to material nature.

I will merely mention some other problems that appeal to us from both analytical and experimental points of view:

(16) The total resistance and the pressure and motions of the air all around a resisting plate, sphere, or other obstacle.

(17) The action of the wind in producing "suction" at the top of an open pipe or chimney.

Among problems that may be handled first by pure mathematics and then by experiment and observation are the determination of:

(18) The calibration correction of a thermometer.

(19) The protruding stem correction.

(20) The Poggendorff correction.

These belong to elementary physics but will give your students a chance to apply their mathematics to physical problems.

A complex trigonometrical problem involving a slight knowledge of astronomy is the determination of—

(21) The duration, and

(22) The intensity of sunshine or the total amount of heat received by a unit horizontal surface for any moment of the day and the year. The calculation is to be made for the outside of the atmosphere, because, if we attempt to make allowance for the absorption by the atmosphere the problem becomes too complex for elementary educational purposes. The simpler problem may be treated geometrically and graphically and is essentially a matter of familiarity with "the use of the globes" as it was called 100 years ago.

(23) Globes and charts are vital matters in meteorology and are elegant classics in geometry. *Chartography* and *projections* and *the globes themselves* are too much neglected—pushed aside by the crush of new demands for instruction in every other branch of knowledge, but these are absolutely fundamental to astronomy and meteorology, terrestrial physics, and all geographic relations. I hope to see them properly appreciated in the schools of pure mathematics and terrestrial physics. The properties and methods of construction of various equal surface projections ought to be as familiar to a student as those of the ordinary stereographic projection. The problems of chartography are beautiful for the drafting room but more vivid and better adapted to the comprehension of many persons if worked out on the globe itself—and one does not need an expensive globe—even a home-made globe or rubber ball can be very useful.

The globes and conic sections in solido should be handled by your students at some early stage in their education.

(24) Finally, to return to our aerodynamics. Nothing can be more attractive to a student than *the formation of a waterspout by* Weyher's method and the study of the wind velocity and pressure, the barometric pressure, the temperature, the vacuum, and the dimensions of the cloud column.

We simply set a horizontal disk at the top of a room or closed case into rapid rotation. Soon the air beneath is dragged into rotation down to the very floor. Below it we place a dish of water and the vapor from it is drawn up into the inner revolving vortex while at the same time thrown outward horizontally; eventually it descends and ascends in regular circulation. As the disk and air increase their rotary speed, the central vortex diminishes in barometric pressure while increasing in velocity, and the moist air flowing into it cools by expansion, forming a central waterspout column or vortex. Here we begin to be stirred with a desire to measure. We insert a long Pitot tube and determine the wind pressure at many points and chart the pressure or velocity on ruled paper. We insert a pair of small plane plates as in my method of barometric exposure (see Meteorological Apparatus and Methods), and determine and chart the pressure at many points. We send a thermometer or thermoelectric junction exploring the vortex and plat the temperature, or we use some form of hygrometer and determine the dew points. In fact we experimentally determine all the elements that enter into the structure of the waterspout and compare our observations with the theories that have been worked out by Ferrel.

I have said enough for the present. I hope to elaborate this effort to help the mathematician and physicist find a new field full of problems for their students. Thus they will help us to develop the talents of future meteorologists.

These are but special illustrations of the general law that thinking, seeing, and doing must go together. We learn by doing as much as by reasoning—each helps the other. Every theory or hypothesis or suggestion should be reduced to exact formula, exact experiment, exact measurement. Precision is the vital essence of all valuable knowledge.

I hope to live to see special schools of meteorology, special laboratories, and mathematical seminaries devoted to this as to every other profession; but for the present at least I urge that you illustrate the value of and enliven the interest of your mathematical and physical courses by frequently quoting or proposing problems drawn from METEOROLOGY.

ON LIGHTNING AND PROTECTION FROM IT.[1]

By Sir JOSEPH LARMOR, F. R. S.

The rationale of electric discharge in a gas is now understood. When a small region becomes conducting through ionization by collisions in the electric field it should spread in the direction in which the field is most intense, which is along the lines of force. Thus the electric rupture is not a tear along a surface but a perforation along a line. This is roughly the line of force of the field; the electrokinetic force induced by the discharge, being parallel to the current, does not modify this conclusion. A zigzag discharge would thus consist of independent flashes, the first one upsetting adjacent equilibria by transference of charge. Successive discharges between the same masses would tend to follow the same ionized path, which may meantime be displaced by air currents.

If the line of discharge is thus determined by the previous electric field, the influence of a lightning conductor in drawing the discharge must be determined by the modification of this electric field which its presence produces. For a field of vertical force, such as an overhead cloud would produce, it may be shown that the disturbance caused by a thin vertical rod is confined to its own immediate neighborhood. Thus while it provides a strong silent discharge from earth into the air, it does not assist in drawing a disruptive discharge from above—except in so far as the stream of electrified air rising from it may provide a path. It is the broader building, to which the rod is attached, that draws the lightning: the rod affords the means of safely carrying it away, and thus should be well connected with all metallic channels on the building as well as with earth. It is the branching top of an isolated tree that attracts the discharge; a wire pole could not do so to a sensible degree. Separate rods projecting upward from the corner of a building do not much affect the field above it, but if they are connected at their summits by horizontal wires, the latter, being thus earthed, lift up the electric field from the top of the building itself to the region above them, and thus take the discharge which they help in attracting, instead of the building below them. Similarly, when the lines of force are oblique to a vertical rod, its presence does somewhat modify the field and protect the lee side; but generally the presence of a rod should not ever be a source of danger, unless the ionized air rising from it provides an actual path for discharge.

[1] *Reprinted from* Report British Association for the Advancement of Science, 83d meeting, Birmingham, September 10-17, 1913. London, 1914. Section of Mathematical and Physical Science, p. 387.

LIGHTNING INJURY TO COTTON AND POTATO PLANTS.*

By L. R. JONES and W. W. GILBERT.

[*Abstract* of a paper presented to the Sixth Annual Meeting of the American Phytopathological Society, Philadelphia, Dec. 29, 1914-Jan. 1, 1915.]

Literature contains meager data concerning lightning injury to herbaceous plants. The authors have evidence that such injury is not uncommon in certain crops, notably cotton and potatoes, and may occur in beets, tobacco, and ginseng. Grass, small grains, and corn seem less liable. Cotton and potatoes when so struck may be killed in roundish spots, 1 to 3 rods in diameter or sometimes several associated smaller spots. There may be no disturbance of soil or physical rupture of plant tissues. The plants near the center wilt, blacken, and die promptly; about the margins some may live days or weeks. Such weakened cotton plants yellow or redden. The injury appears first and worst from the soil line or a little above downward, but may not kill all the underground parts. Partially injured cotton plants may form callus ridges above point of injury and new potato shoots may sprout from base of injured stems. These various facts suggest the theory that when a sudden electric storm follows upon a period of dry weather, lightning discharge spreads horizontally over the moist surface layer of soil and that certain crops are more liable than others, either because of relative tissue resistance or because of character or distribution of aerial parts or root systems.

WEATHER AND HEALTH.

The Notices of the Imperial Academy of Sciences of Vienna for June 25, 1914, contain a brief statement of the results of a recent investigation of the important question as to the connection between weather and human health, undertaken by Dr. Ernst Brezina and Wilhelm Schmidt at the Austrian Central Meteorological Institute in Vienna and presented to the Academy on June 14, 1914.[1]

Heretofore, as the authors showed, this question has been treated largely if not entirely from the standpoint of the physiologist; therefore it seemed all the more promising to follow more the methods of meteorology and to subdivide the weather more minutely into its elements, thus of course adopting a purely statistical method of treatment.

An unprecedently large and explicit series of meteorological elements, from the records of the Central Meteorological Institute, were compared by a specially appropriate method, day for day, with a series of daily values which presented in a somewhat quantitative manner the condition and behavior of extensive groups of healthy and ill persons. For the present investigation Brezina and Schmidt employed: (1) Records of the average hourly work accomplished by a large number of female employees of the Imperial Census Commission, in punching the counting cards (Zählkarten) (*light mental office work*); (2) the recorded daily number of epileptic attacks (i. e., number of patients affected) among the inmates of the hospital for mental and nervous diseases "Am Steinhof" (*condition of the sick*); (3) daily general estimates of the per-

* *Reprinted by permission* from Phytopathology, No. 6, December, 1914, 4: 406.

[1] *Summarized in* Meteorologische Zeitschrift, Braunschweig, Jan. 1915, 32: 43-44.